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Developing Human Resources to Support Japan's International Competitiveness in Industry

– Human Resource Development Model for the Steel Industry, One of Japan's Key Industries –

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1 Introduction

Anticipated changes in the labor force population between the ages of 15 and 64 in different countries between now and 2030 (Figure 1) show that the labor force populations in China and India are expected to increase to about one billion each. Over the same time period, the populations of the United States, Japan, Russia, and the United Kingdom will not change very much: about 200 million in the United States, about 80 million each in Japan and Russia, and about 40 million in the United Kingdom (changes in the make-up of the population and population aging are not taken into account). A look at steel consumption per person (an indicator of industrialization) suggests that even if steel consumption in India (where the total population is approx. 1.2 billion and steel production is 44 million tons) in 2030 were to be half of the current world average of 140kg per person, demand would still increase by 40 million tons even if the population remained constant. Forty million tons is more than the amount of crude steel produced by a Japanese steel company ranked about second in the world in terms of production (such as Nippon Steel Corporation or JFE Steel Corporation).

Considering changes in the environment surrounding steel over the next 20 years based on the relationship between demographic changes and steel products, it is apparent that not only quality improvement through technological development, but also global changes in industrial structures need to be considered. Looking forward to 2030, the largest issue for the steel industry is how to deal with these great changes in the environment. For that, comprehensive technological capacity will be necessary, and instead of vague long-term human resource education, concrete medium-term programs that look over the next 20 years or so need to be examined.

The Japanese steel industry, emphasizing quality, has been growing while keeping up with the

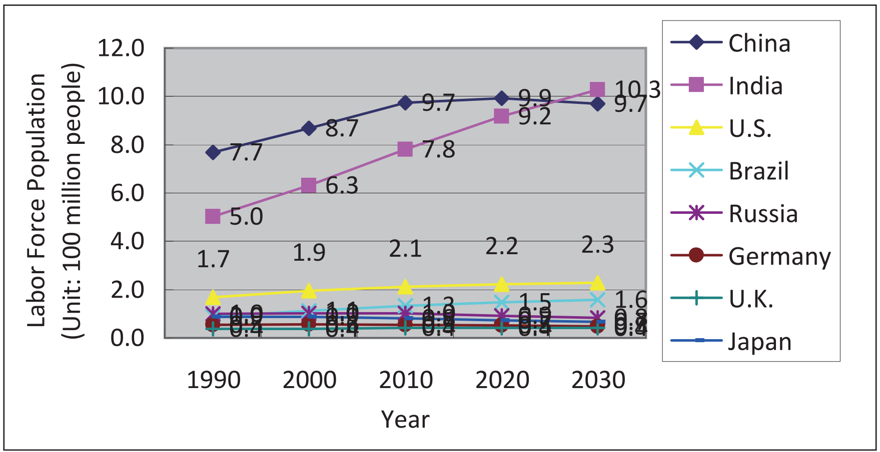

Figure 1 : Trends of the Labor Force Population

Prepared by the STFC based on Reference[1] increasing demand for steel in emerging nations. It has also been responding to users' shift to overseas production. Looking toward 2030, the demand for steel products is expected to increase substantially. In order for Japan to continue to be a key player in the world, establishing a global steel product cycle that includes a recycling system is essential. Looking at world trends, Europe focuses on a recycling system with the use of material marking but does not pay much attention to collecting materials from mixed scrap. Advancements in recycling technology have not been seen either. In the United States, a supply (recycling) system of raw material scrap has not been established. As such, full advantage has not been taken of their smelting technology.[2] The Japanese steel industry must play a major role in building a global cycle of steel products. For this, the industry needs to actively use its smelting technology overseas and educate professionals in acquiring the comprehensive technological capacity to construct a global recycling system.

2 Backcasting in Human Resource Development

According to the ranking compiled by the International Institute for Management Development (IMD), Japan's international competitiveness was at the top level in the 1990s but deteriorated to 27th in 2002. In 2006, it temporarily rose to 16th but declined again to 24th in 2007. Additionally, according to the Japan Center for Economic Research, Japan is not doing so well in terms of potential economic competitiveness, ranking 12th in 2006 and 13th in 2007. With these considerations in mind, this author would like to focus here on human resource development in those industries that aim to improve international industrial competitiveness and to reexamine human resource development using the backcasting approach (which can be a core concept for technological management). This does not mean an examination of continuing study programs. Backcasting was a concept proposed by Dr. Karl-Henrik Robèrt, founder of The Natural Step, an environmental NGO in Sweden. He suggested that the environment would not improve in the desired direction via the "forecasting" approach (which analyzes the past and the present to predict the future) and instead proposed the opposite approach of defining an ideal future and working backward to determine what needs to be done in the present.

The backcasting approach as used in this article for human resource development means defining an ideal professional in his/her late 30s or 40s, who is expected to play a major role in enhancing industrial competitiveness, and to work backward to establish human resource development programs that will connect that future to the present. By identifying what qualities and knowledge need to be acquired at which career stages, it should be possible to establish human resource development policies according to the type of industry and business (Figure 2). This approach aims to achieve high labor productivity among professionals in their late 30s and 40s. By analyzing what expertise and general knowledge they should have acquired before reaching their late 30s and 40s (back to when they are in their late 20s and around 30), we will be able to create development programs to connect the future to the present. Once the prerequisite qualities and knowledge have been determined for those who have graduated from college and spent several years in industry, this approach can also determine what they need to have learned by the time they finish their undergraduate, masters, or PhD programs.

Steel engineers who are expected play a major role in 2030 should acquire sufficient specialized knowledge, as well as the capacity to conduct all-around activities and the capability, through collaboration with other fields, to innovate. To achieve this, engineers need to learn about related technology and management, in addition to their expertise, when they are in their 30s. In their 20s, they need to have an understanding of a wide range of knowledge and ideas about steel in addition to specialized college-level knowledge. When educating people who are currently in their 20s to improve industrial competitiveness in 2030, it is essential to define a desirable future and identify concrete requirements whenever we discuss human resource development for young people. It is also essential that the discussion lead to the establishment of development programs in each company or in the industry. If we can clarify the

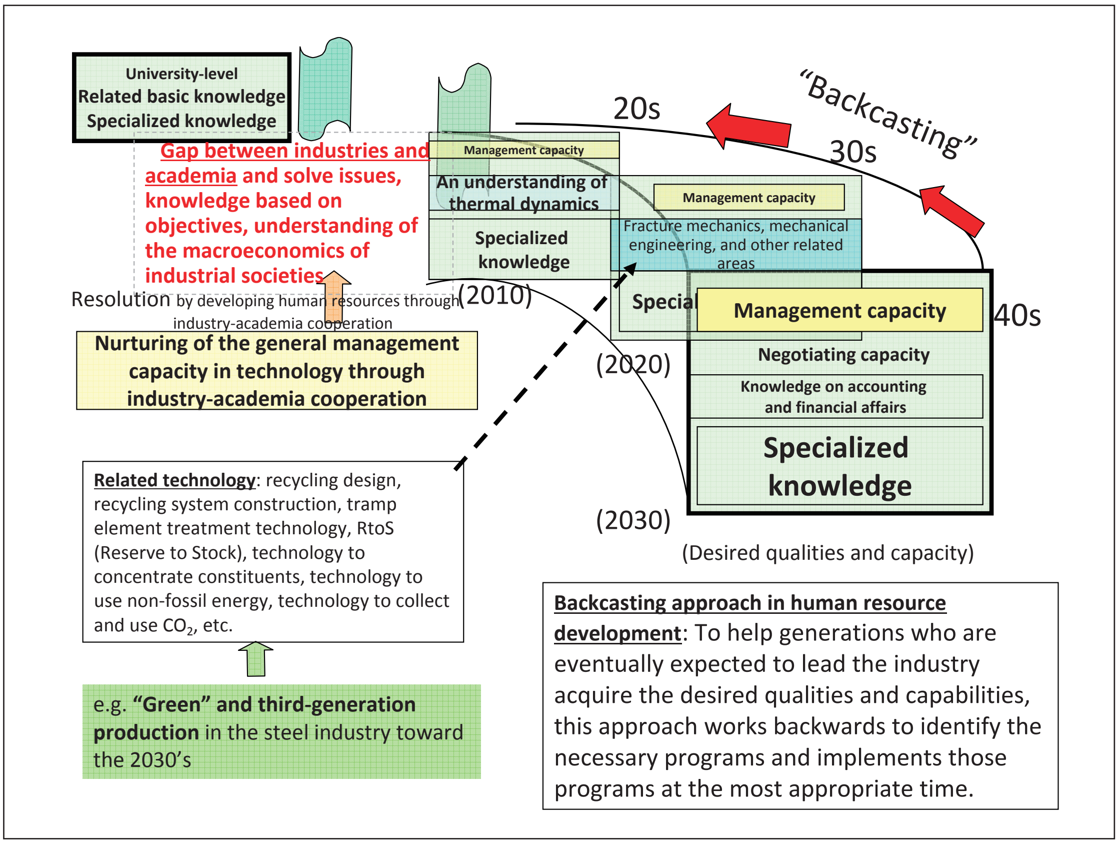

Figure 2 : Backcasting Approach in Human Resource Development

Prepared by the STFC

gap between the above-mentioned requirements and the curriculum taught in school up to college, we can also clarify what kind of human resource development programs the industry and academia need to create together.

Figure 2 also shows the gap between current college graduates and the professionals that the steel industry desires, assuming that such people will become key engineers in their 40s in 2030. Additionally, key engineers in 2030 will need to be able to comprehensively manage basic technology (such as establishing recycling systems and technology to treat tramp elements, concentrate constituents, and to collect and use CO_2) in order to respond to the need for green production and third generation steel production. As such, in addition to their specialized technical fields, they will need to promptly understand and master management of technology (MOT). MOT should be taught in college engineering classes rather than in post-college education. In particular, industry and academia need to work together to create a program that teaches the basics of MOT, such as how to identify and solve issues, as well as the macroeconomics of industrial societies. If the gap between industry and academia is closed, we can expect PhD graduates to work effectively immediately after they join the industry.

Below, I will discuss an industry-academia partnership to develop human resources in the steel industry field. I will also review existing and new efforts conducted by the steel industry. Additionally, I will consider how the gap between industry and academia is expected to be closed and what issues must be addressed to improve industrial competitiveness.

3 An argument about personnel training

3-1 Discussion of the Industry-Academia Partnership Project for Human Resource Development

In fiscal 2007, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry launched the Industry-Academia Partnership Project for Human Resource Development, with the goal of achieving sustainable and dynamic growth in the Japanese economy and of making it possible for

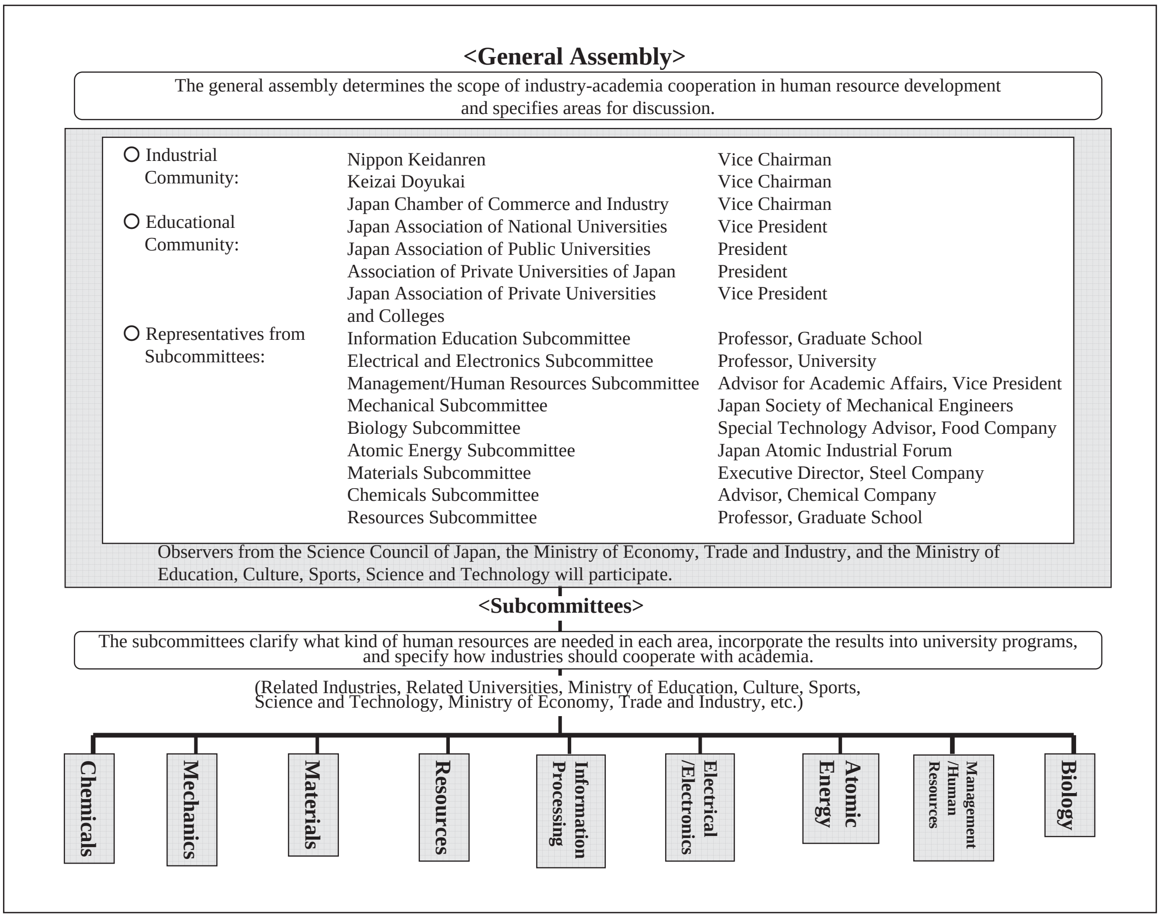

Figure 3 : Industry-Academia Partnership Project for Human Resource Development (General Assembly and Subcommittees)

Prepared by the STFC based on Reference[3]

the Japanese people to enjoy contented lives at ease.[3] This project targets nine industrial areas and explores industrial human resource development policies. Active exploration is underway with the materials field as one of these key areas (Figure 3). The materials subcommittee (the secretariat: Iron and Steel Institute of Japan) has been actively discussing issues as well as solutions in the industrial and educational communities, and has proposed concrete actions that industries and academia should take together.

The interim report states the following (summarized by this author based on Reference[3]).

Japan is a nation built on exporting internationally competitive products overseas. It is crucial to maintain a high and stable quality of materials as the basis for final products, and to develop technology toward innovative materials for the future.

As Figure 4 suggests, the ferrous and non-ferrous industries directly accounted for only 8% of all manufactured goods shipped. However, the competitiveness of mechanical products and automobiles and other transportation equipment also depends on ferrous and non-ferrous materials gualities. As such, the ferrous and non-ferrous industry is a key industrial area, supporting Japan's manufacturing. In particular, international competition in materials industries has become fiercer as the operations of automobile and electrical industries globalize. Thus, it is more important than ever to strengthen the research and development capacity for global advancement. Additionally, there is a greater need for resource-flexible and environment-friendly technology. It is especially essential for the ferrous and non-ferrous industries to aim to prevent global warming and to engage in other environmental activities, as they emit 40% of the total CO_2 emissions produced by industry. As the need for advanced technological development increases, the materials industry seeks excellent human resources who can maintain high-grade manufacturing technologies and overcome obstacles that are more challenging than ever before.

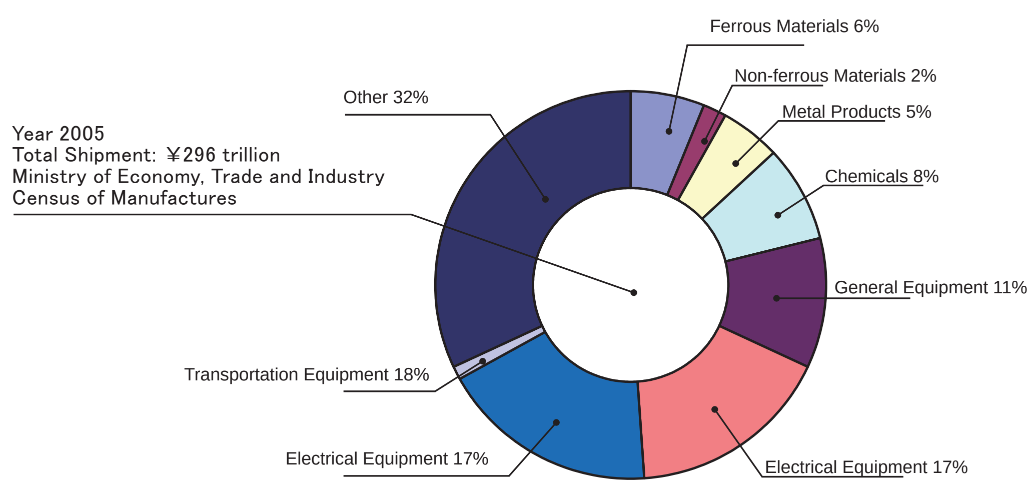

Figure 4 : Shipments of Japan's Major Manufacturers

Source: Reference[3]

A look at universities with materials technology departments reveals that the number of departments that teach metallurgy and other subjects concerning metal materials has been decreasing, and that the gap between the industry and universities has been increasing in terms of what should be taught in college. In addition, possibly due to insufficient PR, the number of students who want to study materials technology has been decreasing compared to other technological areas. Thus, some universities are having difficulty keeping these departments and majors. Materials technology is built on many different basic technologies. As such, it is difficult to achieve a one-to-one correspondence between industrial issues and scientific and technological issues. This is one reason that the materials field is so difficult for students and the general public to understand. So far, Japan's materials technology research has maintained its world-class status, but acquiring scientific research funding is becoming more difficult in some areas. As such, the progress of future research and development is becoming a concern. Now that national universities have become independent administrative institutions, assessments of university education and research depend more heavily on objective numeric data such as the rate of filling vacancies in graduate school, the number of articles submitted, and the number of presentations at international conferences.

Additionally, the number of job openings in materials industries has been influenced greatly by the changing economy. The number of new graduates hired by steel companies decreased substantially around 1993. If the number of new graduates hired around 1985 were to be represented by the value 1, this number hovered around 0.5 over the decade following 1993. According to a survey targeting major steel companies, the number of new employees who had studied materials technology was about 350, and more than 90% had master degrees. In light of these circumstances, now is not the time to abstractly discuss human resource development through industry-academia cooperation, but rather it is the time to consider concrete development policies.

Based on the above discussion at the materials subcommittee, an industry-academia partnership project for human resource development in the steel industry was proposed, and in 2008, it was adopted as the Industry-Academia Partnership Project for Human Resource Development by the Ministry of Economy, Trade and Industry.[4] The proposal was made by the Japan Research and Development Center for Metals in cooperation with steel companies and university teachers with the aim to formulate a sustainable industry-academia system following a three year trial period. The Project plans to build on the strengths of existing materials classes at universities and to create a consortium between universities in order to cover the necessary educational areas. Steel companies also plan to provide educational materials that reflect advanced technology to universities. Additional characteristics include a MOT program that covers the characteristics of the steel industry and includes case studies, and a new internship program incorporating suggestions from companies and providing students with relatively long-term opportunities for research and training through cooperation between universities and companies.

Cooperation and information sharing between industry and academia are essential in order to have university teachers better understand the current state of the industry and incorporate it into their classes. The existing human resource development programs in the steel industry target company engineers, but the above-mentioned proposal aims to develop full-fledged university education programs through industry-academia cooperation. It is expected to create effects that have not been realized through individual efforts by industry and academia. Furthermore, in order to stabilize the results of these efforts, the creation of educational materials and curricula as well as legal agreements and other infrastructures is necessary. For example, in order for industry and academia to accept the mutual flow of company employees, university teachers, and students, it is essential to establish a wide-ranging, concrete system covering insurance and intellectual property. To do so, support from the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry will be needed.

3-2 Discussion of Human Resource Development to Support Industrial Competitiveness in the Steel Industry

According to the Fundamental Issues Subcommittee of the Industrial Structure Advisory Council at the Ministry of Economy, Trade and Industry, the emphasis of Japan's industrial policies changed from "quickly promote key industries" to "let the market determine the key industries now that Japan has 'caught-up' economically and has become a developed country." The subcommittee also stated that the role of the government was to "maintain the market system and deregulate and abolish unnecessary regulations" and recognizes that Japan now faces issues such as declining birthrates and an aging population, bipolarization, and regulations concerning resources and the environment. The same subcommittee concluded that "Japan's environmental technology and strength coming from on-site monozukuri (manufacturing)" are the basic elements for its competitiveness, but that "Japan lacks the capacity to integrate and make the most of those elements and, thus, has not been sufficiently using them," and that, in order to overcome this situation, "Japan needs bold innovation and creativity gathered from every part of the country, that can change conventional technology and know-how." The subcommittee also pointed out that the japanese steel industry "should provide solutions services concerning environmental technology and attempt to both promote and find a way to receive compensation for them."[5]

However, the prices of ore and coal became 4.9 times higher between April 2000 and April 2008[6] and production decreased by 30% compared to the previous year due to the slowing economy in the latter half of 2008, and thus, the steel industry's profits have been declining. Additionally, to reach the goal of halving greenhouse gases by 2050, drastic reforms in the energy supply structure are required. Considering these circumstances, creativity that goes beyond conventional ideas is essential.

The steel industry has been active in investing in development. In fact, three steel companies ranked in the top 100 in a 2006 ranking of private research and development investment in Japan.[7] This research and development ranges widely from product development such as "design-in [Note 1]" with automakers to process development to reduce CO_2 emissions. Unlike the post World War II period, when nations promoted projects in pursuit of industrial competitiveness, it has been suggested that there will be more issues that can be solved only through open innovation, such as efforts to stop global warming. According to a report on the United States conducted by the Ministry of Economy, Trade and Industry, some experts suggested that "vertical cooperation was common in consortium projects in the United States and that the emphasis was on how companies in the same industry cooperate in research and create results."[8] To do so, it is essential to develop and secure human resources who can propose projects that respond to changes in the environment surrounding the industry.

It is true that the steel industry is often seen as symbolic of the old economy and that the number of students who choose to study in this field is declining. However, the steel industry has been conducting open innovation efforts and, through competitions and cooperation, has also been supporting Japan's industrial competitiveness since World War II. Of course, human resource development in the steel industry has emphasized technology, and individual persons and companies have been responsible for educating themselves and employees as engineers and researchers who can compete internationally. However, considering recent severe economic conditions, where the industry cannot even afford to conduct on-the-job-training (OJT),[Note 2] educating people to become engineers and researchers who can negotiate on the world stage is an important matter affecting more than a single industry, and as such, should be included in national policy. It is now necessary to define a desirable future and examine, in concrete terms, human resource development programs that include university education. It is also expected that by clarifying future requirements (namely, the relationships between age, knowledge, intelligence, etc.), job opportunities will increase for PhD graduates, who will be able to immediately start working effectively in the industry.

The Japanese steel industry is said to have matured and growing sluggishly. To maintain international competitiveness in the midst of the global economic downturn, the industry has been conducting in-house education and, in order to solve issues that are common throughout the industry, has been developing engineers. The Industry-Academia Partnership Project for Human Resource Development (Figure 3) groups together industries in related fields, but the steel industry has been working closely not only with the materials field but also with other fields. Thus, it is essential to discuss human resource development in the industry in a more cross-cutting manner than ever before.

4 Issues and Cases of Human Resource Development from the Perspective of Current Industrial Competitiveness

4-1 Issues in the Japanese Steel Industry

In 2007, the world's crude steel production surpassed 1.3 billion tons, of which Japan produced 130 million. Japan's overall production was almost equal to the amount produced by ArcelorMittal, the world's top producer. Looking at production by country, China's production has increased by more than 20% each year to reach around 500 million tons (Figure 5). There are several hundred steel companies in China, and these conditions are expected to continue at least until the 2010 World Expo in Shanghai.[9] China and ArcelorMittal are by far the largest producers among countries and companies, respectively. Due to the oligopoly situation, each company's price negotiation ability toward mine-suppliers is limited. The Japanese steel industry has its strength in high-quality steel, but it will be necessary to work with middle users such as automakers and the shipbuilding industry in order to maintain and improve industrial competitiveness. To achieve this, continuous technological and product development and innovation are required.

In 2008, the Japanese steel industry celebrated 150 years of modern iron making. On December 1st, 1858, Takato Oshima from the Nanbu domain (present-day Iwate prefecture) succeeded in the

[NOTE 1]
Design-in : Engineers from both the producer and the user sides communicate, beginning from the designing stage, to create products that have characteristic functions.

[NOTE 2]
Acquisition of knowledge, technology, skills, behaviors, etc. required for work as a result of teaching through actual work (from superiors and experienced workers to subordinates and less experienced workers).

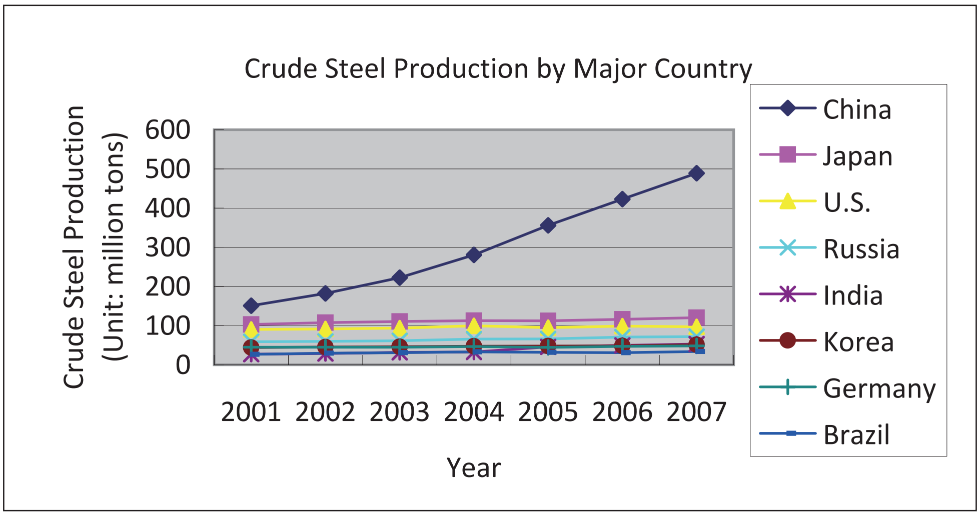

Figure 5 : Crude Steel Production by Major Countries

Prepared by the STFC based on Reference[10]

continuous production of pig iron using a Japanese-style blast furnace. To commemorate his success, December 1st is the anniversary of iron making in Japan. The success of the Japanese-style blast furnace was the result of continuous improvement efforts based on Japanese know-how, and did not just rely on the introduction of foreign technology. This point is reinforced by the fact that a foreign engineer employed by the Meiji government later failed in iron operations. Similar continuous innovation has been conducted throughout the history of the steel industry.

In his "Comparative Analysis of the Integrated Steel Companies in East Asia,"[11] Nozomu Kawabata characterized the first generation of the integrated steel making system by the location of ore and the second generation by the waterfront industrial areas in the 1960s and 1970s in Japan. He defined the third generation as "a production system that solves problems of mass production, establishes more flexible production, and substantially advances resource and environmental control." The current steel industries of Japan and the United States basically follow the pattern of the second generation (defined by Kawabata), typical of mass production, but also incorporate flexible multi-variety small-lot production, and thus, are considered to be second-and-a-half generation.

Due to the drastic economic downturn in the latter half of 2008, worldwide pig iron production from blast furnaces decreased compared to the previous months, except in China. Comparing August and December of 2008, production declined more than half in some countries (Figure 6). According to the "common sense" of furnace experts, changes in production had been normally limited to 10% per month. As such, the industry is experiencing a once-in-a-century situation. However, the potential global demand is steady. Thus, it is important from both the management and the technological perspective to secure production capacity while enduring the current decline in production. Technological development concerning the elasticity of production is also essential. The steel industry must regard the current situation as an opportunity to establish tools for elastic production and let young engineers take over in order to establish third-generation steel production.

If we consider the future environment surrounding the steel industry and focus on industrial competitiveness in 2030, then in order for Japan's manufacturing industries to survive through high value final products, it will be necessary to maintain either high quality that others cannot keep up with, or price competitiveness. Additionally, the worldwide average demand for steel is expected to be close to 250kg per person in 2030 (the same level as Korea at present). If demand goes up any higher, due to the drastic increase in the demand for steel to be used for machinery, the ratio of copper to be mixed into iron materials is expected to surpass 2.8%, producing a large amount of non-recyclable iron scrap.[12] Japan has established a materials sorting system using, for example, a shredding process,

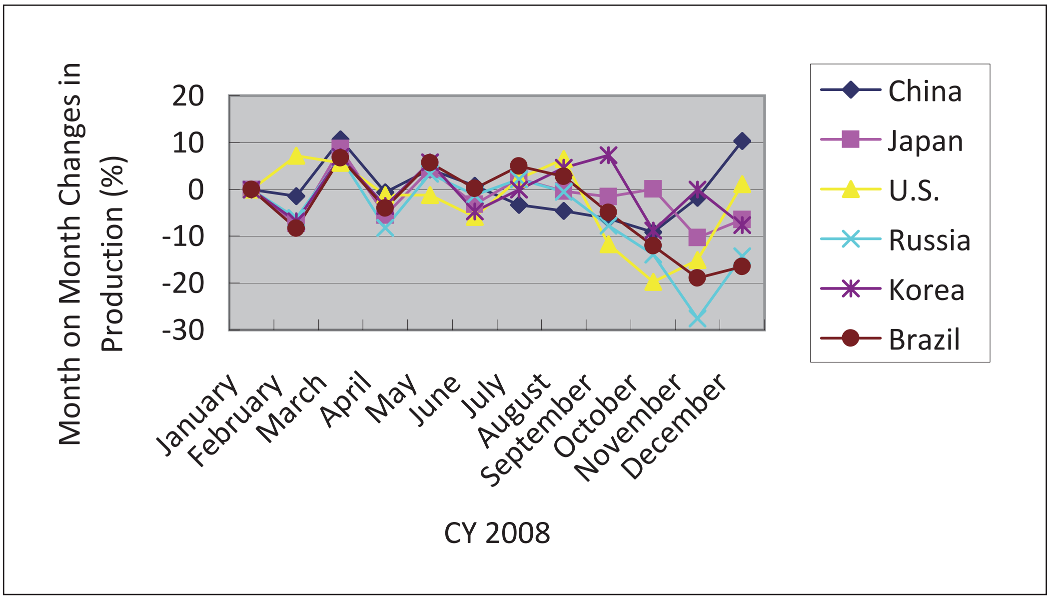

Figure 6 : Monthly Changes in Pig Iron Production from Blast Furnaces

Prepared by the STFC based on Reference[10]

but there are not yet sufficient technologies or systems to deal with copper-mixed scrap on the global level. Looking toward 2030, it is essential to technologically respond to the increase in factory scrap from overseas. Technologies currently being explored include technology to remove the undesirable effects of copper and other impurities (tramp elements) and other technology to actively use such impurities to improve the quality of materials. It is desirable for waste treatment to shift from the conventional disassembly-sorting-smelting process to RtoS (Reserve to Stock: disassembly, separation, concentration, and smelting).[2] To be competitive on the world stage in 2030, it is essential both to maintain a scrap-based control system and to establish a customized multi-variety production system.

The steel industry has increased its production, with the auto industry as its main user. However, to work with a variety of users in the future, shifting to green and third-generation steel production is essential, and the key words to do so are: minimum CO_2 emissions (a new iron making process, high-efficiency smelting, production of appropriate amounts in the appropriate places, under high pressure), low-quality materials (low iron content, low-quality coal, location near mine-suppliers, supply chain), low alloy-containing steel (minimum additives, new processing, element separation recycling), design for longevity (bridges, reinforcement for high-rise buildings, replacement, design for easy disassembly), material flow design (material circulation, element circulation, element cost), etc. In order for iron to continue to be a key material in 2030, it is necessary to integrate, based on materials-related technology, various scientific and technological fields, such as mechanical, electrical, and chemical engineering as well as plant design and financing. Temporarily reducing production is not sufficient to respond to the current economic downturn. Rather, it is important to take this opportunity to come up with technological and management ideas to realize elastic production systems.

4-2 Human Resources in the Japanese Steel Industry

High monozukuri (manufacturing) technology as well as high-quality materials that ensure reliability in final products supported the high economic growth of the post-war era, the stable growth that followed, and the industrial competitiveness fostered in those periods of growth. Steel products are symbolic of those high-quality materials. For example, the tensile strength of high tensile steel sheets (which are mainly used for automotive exterior panels) has been around 40 for about 40 years, but it is now over 70 in some panels (tensile strength: sample bar strength measured at the time when the bar breaks in a tensile stress test in units of kgf/mm^2). As a result, steel products strong enough to use in automobiles now weigh about

20% less,[13,14] contributing to fuel efficiency. The tensile strength of steel plates for ships has also improved, and larger container ships can be now built, sharply reducing transport costs. It is high quality materials that make technology possible, and people in the steel industry have played a key role by developing and manufacturing such high-quality materials. The efforts were made by a wide range of experts in not only material manufacturing technology, but also in welding, plasticity processing, and surface treatment technology or so.

One characteristic of Japanese industry is that manufacturers of materials and users of materials, such as automobile companies, share information and start working together from the design stages to develop materials. Cars are consumer products. As such, car companies tend to become the center of people's attention when we discuss the automobile industry. However, material companies cover materials and processing technology, and steel company engineers play a substantial role in the overall technology. Ohashi, et al.[15] defined user innovation [Note 3] as the way that users of introduced technology gain a thorough knowledge of products (or introduced equipment) by committing to the improvement of how they are used and their performance. Ohashi, et al. gives an example case where steel companies imported production technology of the basic oxygen furnace (BOF) from overseas, a dramatic development in the industry. At that time, BOF was facing some serous technological problems. Thus, it was essential to solve those problems before the technology could become used widely. It was a Japanese steel company that created the technology to solve these problems. This achievement was the result of a high level of expertise among on-site iron-making professionals.

However, for third-generation steel making, it is essential to aim to transcend conventional technology, and the Japanese steel industry needs to create an atmosphere of open innovation and to respond to cirumstances. To do so, the way we nurture engineers and developers in various areas over the next ten to twenty years is important, and this should be different from an extension of the existing production technology.

Some, from the perspective of production management, attempt to understand that the strength of the Japanese manufacturing industries comes from the post-war lifetime employment system and that Japanese in-house human resource development is a variation of McGregor's theory X.[16] This view is based on a social environment where human resources are relatively static. Currently, major steel companies are able to conduct in-house human resource development programs targeting specialists. However, small and medium-sized companies are having difficulty in passing on their technology to younger generations, and human resources are fluid. To respond to this situation, the Japanese steel industry has been conducting industry-wide basic technological development programs, taking advantage of the industry's culture of cooperation and competition nurtured during the period of reconstruction following World War II. In addition, it is also necessary to cultivate generalists who have expertise in responding to sudden changes in the socio-economic environment. It is hard for a single company to achieve this kind of human resource development. Thus, some companies, through the coordination of the Iron and Steel Institute of Japan, are aiming to conduct a joint program.

4-3 Human Resource Development Efforts by Industry Association

Here, I will introduce human resource development efforts being conducted by the steel industry association.

Human resource development programs conducted by the Iron and Steel Institute of Japan are planned and managed by a development

[NOTE 3]
In recent years, marketing methods that emphasize user innovation have been popular. Those methods include, for example, product line-ups based on data and requests from internet buyers (market development), or the involvement of (information) equipment users in development (of terminal equipment). Ohashi, et al. extended this concept.

committee comprised of people from both companies and universities. Development programs in Figure 7 include "steel engineering seminars," "specialized steel engineering seminars," and "advanced steel engineering seminars." They are provided for a fee, and each program is basically operated on a for-profit basis. Currently, all programs are turning slight profits. This suggests that the programs meet the needs of the present generation and are well-received, including how they are managed.

A steel engineering seminar is held every year. It targets young individual members (including non-Japanese members) of the association, who are mostly in their 20s and have three-to-five-years of experience in the steel industry. Many engineers and researchers have participated over the years. The course aims, for example, to provide an employee whose college major was mechanical engineering or electrical engineering with an opportunity to relearn the basics of materials or metallurgy. The course can also be a good opportunity to meet people in the same field from different companies, and many people seem to keep in touch with each other and exchange ideas. Each time, there are some 150 participants. They attend lectures and engage in discussions while staying at a hotel in Zao for a week. On the last day, groups of participants make presentations based on earlier group discussions, and excellent presentations receive an award. The teachers come from both academia and industry (about half and half in number) and their term lasts for two years. The teaching experience becomes a valuable asset especially for company employees who are in their 40s and in management (mainly department chiefs). In other words, the seminar effectively trains not only the participants but also the teachers. Applicants usually apply through each company's human resources department, and this proves that the programs are considered human resource development tools.

The specialized steel engineering seminars target engineers and researchers who have taken the steel engineering seminar and desire to learn more about specific areas. Each year, the human resource development committee of the association asks university professors to suggest themes

1) Steel engineering seminar (Zao seminar)

Target: Engineers and researchers who have several years of experience in the industry

Number of participants/duration/content: About 150 participants/one week retreat/three courses: iron making, steel making, and material and rolling

2) Specialized steel engineering seminar

Target: Those who have completed the steel engineering seminar

Number of participants/content: About ten participants in each course/taught by specialists from each specified field (actual subjects taught in 2007: cast structure control/high-temperature deformation and processing/properties of melted iron and slag/thin sheet press molding)

3) Advanced steel engineering seminar

Target: Mid-career employees (mainly section chiefs)

Number of participants/content: up to about ten participants each/three courses in iron making, steel making, and material and rolling, aiming to nurture human resources, mainly through discussions, who will eventually play key roles in the industry

(The 2008 seminar was conducted at the Kanagawa Science Park from October 23 to 25. Eight participants in iron making, eleven in steel making, and fifteen in materials. Keynote speech: Professor Kawabata from the Faculty of Economics, Tohoku University, "New Phase of the Steel Industry in East Asia.")

Figure 7 : Human Resource Development Programs Conducted by the Iron and Steel Institute of Japan (Fiscal 2007)

Prepared by the STFC

for the seminar, and company employees who are interested in those themes can participate. More than ten applicants are required to hold the seminar, and company employees are appointed as organizers to conduct the seminar smoothly. The advanced steel engineering seminars target mid-career employees (mainly section chiefs in their 30s) who have taken the steel engineering seminar and are eventually expected to play a key role in engineering and related areas. During a two-night and three-day retreat, participants are divided into three groups (iron making, steel making, and materials [rolling]) and, according to predetermined themes, engage in discussions including those on technological perspectives. Without revealing their companies' intellectual property or know-how, the participants discuss future technological prospects in groups and each group gives a presentation at the end. More experienced company employees and associate professors in their 30s serve as discussion moderators.

The current human resource development programs being conducted by the Iron and Steel Institute of Japan have taken shape in accordance with the needs of the industry and universities' desire to teach practical knowledge. Moreover, thanks to countless efforts by those who recognize the importance of cooperation and who were involved in the management of the programs, continuous improvements have been made. However, it took over 30 years to reach this point, suggesting the difficulty of conducting a human resource development program. The current programs were not created based on the backcasting concept, but they now provide different learning opportunities for employees in their 20s, 30s, and 40s.

4-4 Proposing Solutions for Issues of Human Resource Development in the Steel Industry

In this section, I will use the backcasting approach shown in Figure 2 to examine the human resource development programs conducted by the Iron and Steel Institute of Japan in order to make further improvements.

Firstly, it is necessary to share, among the industry and academia, issues that concern how to maintain and improve the competitiveness of the industry between now and 2030. Next, we must picture human resources in the future who can promote the innovation necessary to respond to changing environments and to maintain and improve Japan's industrial competitiveness. To do so, we need to urgently consider industry-academia programs targeting young engineers and students in materials engineering or other areas in their 20s. For example, establishing technology to use recycled alloy steel and creating a system to minimize CO_2 emissions are essential. To realize this, developing elemental technology and cultivating technology to integrate such elemental technology as well as developing human resources who will play key roles in these activities are necessary. In engineering classes at universities, students should, at an early stage of their education, acquire MOT capabilities in addition to knowledge in their specialized fields. We should help students understand the actual state of the industry and introduce a MOT program to improve their overall capabilities. Students should learn, before they join a company, about project management, making them able to find issues, develop technology, and achieve goals.

At the Central Education Council of the Ministry of Education, Culture, Sports, Science and Technology, university-related professionals have been discussing how university education should be from a mid and long-term perspective. The council stated, "college graduates require high intellects to be able to compete internationally in a globalized world,"[17] and aims to improve the quality of college education. This author hopes that there will be further discussion involving various sectors in order to clarify the objectives of the human resource development much needed by society, and, using the backcasting approach, to conduct appropriate programs at appropriate times without being confined to the existing programs. For example, based on the result of industry-academia efforts, I hope that there will be discussion on closing the gap between industry and academia by, for instance, incorporating what has been taught at companies into university curricula. As discussed in Section 3, the Industry-Academia Partnership Project for Human Resource Development, conducted jointly by the Ministry of Education, Culture, Sports, Science ad Technology, and the Ministry of Economy, Trade and Industry, is providing new opportunities for industry-academia cooperation. I hope that this will become an opportunity to use the backcasting approach to discuss what human resources are needed in each industry or company and that we will take concrete action in order to maintain and improve Japan's industrial competitiveness, which can be achieved only through cooperation.

5 Conclusion

In this article, I have introduced human resource development programs being conducted by the steel industry in order to maintain and improve industrial competitiveness. I believe that these programs can be used as model cases for other industries. I have also looked at the industry-academia partnership programs being conducted by the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry, which aim to solve issues that cannot be solved by the industry or companies alone, in the hope that those efforts will close the gap between industries and academia. Currently, we are experiencing a global economic downturn. However, once the financial system is reformed, it is expected that the market will expand to respond to potential demand. Looking forward to 2030, the Japanese steel industry needs to realize third-generation iron making. That is to say, industry must both respond to environmental issues and establish production elasticity. In the future, globalization will not just mean a global flow of money but will also include both physical and mental aspects, which will transcend or even eliminate boundaries. As such, it is expected that each company or industry will not be able to develop human resources sufficiently by itself. Human resource development programs have been conducted through trial and error, but I hope that the backcasting approach will clarify issues and be used to establish, with public support, industry-academia programs that will effectively maintain and improve industrial competitiveness. MOT programs should not only be introduced at universities but also be constantly improved in order to meet the concrete needs of industry. Additionally, although I did not mention it in this article, I believe that there should be a public system in order to develop human resources in small and medium-sized companies who will be able to not only pass technology on to future generations but also work globaly from a management perspective.

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Profile

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